PB-242 820

CASTLE ROCK FLOWAGE, JUNEAU AND ADAMS COUNTIES, WISCONSIN

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
Wisconsin Department of Natural Resources
Wisconsin National Guard

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT

ON

CASTLE ROCK FLOWAGE

JUNEAU AND ADAMS COUNTIES

WISCONSIN

EPA REGION V

WORKING PAPER No. 75

PACIFIC NORTHWEST ENVIRONMENTAL RESEARCH LABORATORY

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WITH THE COOPERATION OF THE

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

AND THE

WISCONSIN NATIONAL GUARD

JUNE, 1975

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conducting the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

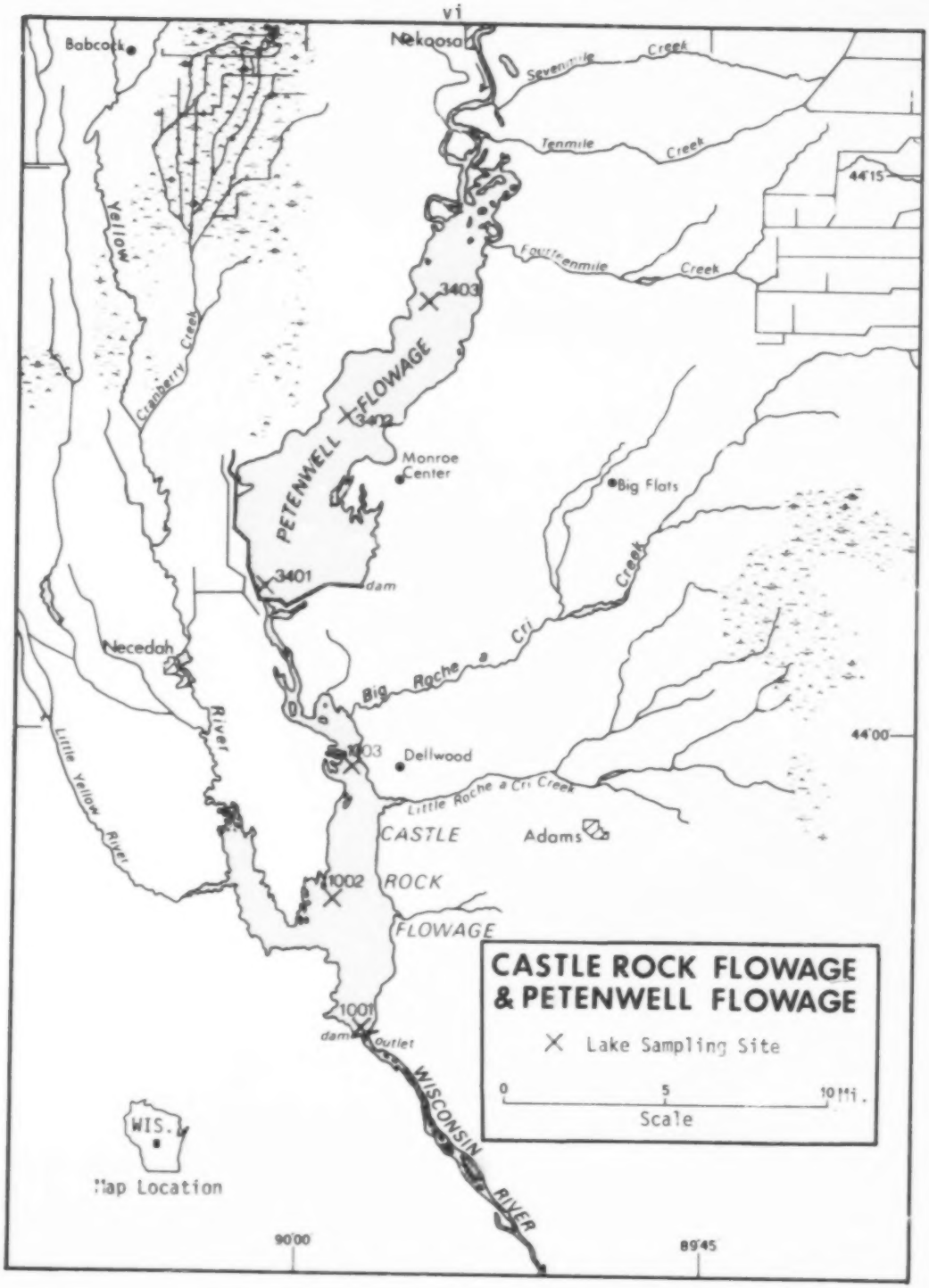
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano
Sinnissippi	Dodge

LAKE NAME	COUNTY
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


Babcock
Nekoosa
Seventmile Creek
Tenmile Creek
44'15
Yellow
Cranberry Creek
Fourteenmile Creek
3403
PETENWELL FLOWAGE
3402
Monroe Center
Big Flats
3401
dam
Necedah
Big Roche a Cri Creek
River
Little Yellow River
1003
Dellwood
44'00
Little Roche a Cri Creek
CASTLE ROCK FLOWAGE
Adams
1002
1001
dam
outlet
WISCONSIN RIVER
WIS.
Map Location
90'00
89'45
CASTLE ROCK FLOWAGE & PETENWELL FLOWAGE
Lake Sampling Site
0
5
10 Mi.
Scale

CASTLE ROCK FLOWAGE

STORET NO. 5510

I. INTRODUCTION

Castle Rock Flowage was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report only relates to reservoir sampling data.

Castle Rock Flowage was formed by a 1950 impoundment of the Wisconsin River near Mauston by the Wisconsin River Power Company. It lies immediately downstream from Petenwell Flowage* and is indirectly impacted by the same domestic, food-processing, and pulp and paper mill wastes that affect Petenwell as well as domestic and food-processing wastes discharged to a major tributary, the Yellow River (McKersie, et al., 1970).

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Castle Rock Flowage is eutrophic. Of the 46 Wisconsin lakes sampled, 20 had less mean total phosphorus, 31 had less mean dissolved phosphorus, 30 had less mean inorganic nitrogen, 33 had less mean chlorophyll a, and 33 had greater mean Secchi disc transparency.

Dissolved oxygen was depressed but not depleted with depth at sampling station 1 in August, 1972. However, severe dissolved oxygen problems occur in the Flowage (Schraufnagel, 1974), and

* Working Paper No. 74.

partial winterkill and summerkill conditions occasionally occur (Klick and Threinen, 1969).

Survey limnologists noted an algal bloom in the southern end of the Flowage in August, 1972.

B. Rate-Limiting Nutrient:

The algal assay results indicate phosphorus limitation at the time the sample was taken (11/08/72). However, the reservoir data indicate nitrogen limitation at the other sampling times.

Castle Rock Flowage may have been somewhat light-inhibited due to absorption by color resulting from pulp and paper mill wastes and natural sources as Kluesener (1968) considered likely at upstream Petenwell Flowage. However, the numbers of phytoplankton and the levels of chlorophyll a during Survey sampling indicate light inhibition was not as important as during Kluesener's study.

III. RESERVOIR CHARACTERISTICS

A. Morphometry†:

1. Surface area: 16,640 acres.
2. Mean depth: 10.5 feet.
3. Maximum depth: 30 feet.
4. Volume: 174,720 acre-feet.
5. Mean hydraulic retention time: 13 days*.

B. Precipitation**:

1. Year of sampling: 42.7 inches.
2. Mean annual: 30.7 inches.

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† Ball, 1973.
* Based on mean Wisconsin River discharge of 6,671 cfs at Wisconsin Dells (Anonymous, 1974).
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Castle Rock Flowage was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three stations on the reservoir and from two or more depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 23 feet at station 1, 10 feet at station 2, and 8 feet at station 3.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the reservoir essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

FALL VALUES

(11/08/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	5.5	5.8	5.9	6.1
Dissolved oxygen (mg/l)	10.2	10.5	10.6	10.8
Conductivity (μmhos)	135	141	140	150
pH (units)	7.1	7.2	7.2	7.4
Alkalinity (mg/l)	25	32	32	36
Total P (mg/l)	0.044	0.048	0.048	0.055
Dissolved P (mg/l)	0.025	0.027	0.026	0.032
NO_2 + NO_3 (mg/l)	0.270	0.298	0.280	0.340
Ammonia (mg/l)	0.120	0.127	0.130	0.140
		ALL VALUES		
Secchi disc (inches)	20	30	33	38

B. Biological characteristics:

1. Phytoplankton* -

Sampling Date	Dominant Genera	Number per ml
08/18/72	1. Anabaena	219
	2. Gloeocapsa	188
	3. Chroococcus	173
	4. Melosira	83
	5. Flagellates	60
	Other genera	211
	Total	934
11/08/72	1. Melosira	3,170
	2. Flagellates	1,887
	3. Fragilaria	981
	4. Aphanocapsa	717
	5. Chroococcus	659
	Other genera	3,152
	Total	10,566

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/24/72	01	102.3
	02	65.9
	03	32.8
08/18/72	01	1.7
	02	6.3
	03	1.3
11/08/72	01	6.4
	02	7.4
	03	5.0

* The June sample was lost in shipment.

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.020	0.390	1.7
0.006 P	0.026	0.390	4.6
0.012 P	0.032	0.390	10.4
0.060 P	0.080	0.390	10.4
0.060 P + 10.0 N	0.080	10.390	40.0
10.0 N	0.020	10.390	1.3

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Castle Rock Flowage was moderately high at the time the sample was taken (11/08/72). Also, the increased yields with increased levels of orthophosphorus indicate phosphorus limitation at that time (note the lack of yield response when only nitrogen was added).

The reservoir data confirm phosphorus limitation in November (N/P ratio = 16/1) but indicate nitrogen limitation in June (N/P = 6/1) and August (N/P = 9/1).

V. LITERATURE REVIEWED

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VI. APPENDIX

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

551001
43 52 00.0 089 57 30.0
CASTLE ROCK FLOWAGE
55 WISCONSIN

11EPALES 2111202
5 0020 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	06 00	0000	19.3	9.2	38	115	7.25	33	0.140	0.080	0.054	0.038
	06 00	0015	19.7	8.8		115	7.31	27	0.160	0.040	0.087	0.040
72/08/18	09 15	0000			33	145	8.20	33	0.210	0.070	0.070	0.041
	09 15	0004	25.7	10.0		153	8.30	35	0.210	0.070	0.065	0.037
	09 15	0015	20.7	4.6		155	6.80	32	0.320	0.180	0.075	0.051
	09 15	0023	20.0	4.0		158	6.85	24	0.350	0.200	0.071	0.049
72/11/08	07 45	0000			22	140	7.40	31	0.280	0.120	0.047	0.025
	07 45	0004	5.9	10.4		140	7.30	33	0.280	0.130	0.048	0.026
	07 45	0015	5.9	10.7		140	7.20	32	0.280	0.130	0.049	0.026
	07 45	0020	5.9	10.6		140	7.20	31	0.280	0.130	0.055	0.032

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	06 00	0000	102.3J
72/08/18	09 15	0000	1.7J
72/11/08	07 45	0000	6.4J

J VALUE KNOWN TO ... ERROR

STORET RETRIEVAL DATE 74/09/30

551002
43 55 30.0 089 58 30.0
CASTLE ROCK FLOWAGE
55 WISCONSIN

11EPALES
5

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	06	35 0000	18.2	9.2	36	115	7.10	27	0.200	0.150	0.085	0.055
	06	35 0010	18.0	9.5								
72/08/18	10	10 0000			33	160	8.20	35	0.260	0.070	0.073	0.046
	10	10 0004	24.8	8.4		158	8.10	35	0.280	0.060	0.063	0.042
	10	10 0008	23.8	7.7		160	7.40	34	0.310	0.070	0.061	0.043
72/11/08	08	05 0000			20	140	7.10	25	0.300	0.140	0.045	0.028
	08	05 0004	6.1	10.2		135	7.20	28	0.280	0.130	0.044	0.028
	08	05 0010	6.1	10.4		135	7.20	29	0.270	0.120	0.047	0.026

12.

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	06	35 0000	65.9J
72/08/18	10	10 0000	6.3J
72/11/08	08	05 0000	7.4J

J VALUE KNOWN TO BE I. ERROR

STORET RETRIEVAL DATE 74/09/30

551003
43 59 00.0 089 57 30.0
CASTLE ROCK FLOWAGE
55 WISCONSIN

11EPALES 2111202
5 0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/24	06	55 0000	18.1	11.6	36	135	6.68	31	0.210	0.230	0.107	0.076
	06	55 0010	18.5	8.4		135	6.70	30	0.220	0.230	0.108	0.064
72/08/18	11	45 0000			33	180	7.10	32	0.430	0.170	0.081	0.052
	11	45 0004	24.1			170	6.90	30	0.470	0.080	0.071	0.061
72/11/08	08	20 0000			20	150	7.30	35	0.330	0.120	0.050	0.028
	08	20 0004	5.5	10.6		145	7.30	35	0.340	0.130	0.048	0.027
	08	20 0008	5.5	10.8		145	7.30	36	0.340	0.120	0.049	0.026

13.

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/24	06	55 0000	32.8J
72/08/18	11	45 0000	1.3J
72/11/08	08	20 0000	5.0J

J VALUE KNOWN TO BE [illegible]